

# Navigation





## Navigation An Introduction

Boats can pass Bonneville Dam on their way up or down the Columbia River by using the navigation lock. This subject area is designed to familiarize students with the navigation lock and inland trade.

The first section includes activities for the classroom intended to introduce the subject of navigation to your students. Next, are activities that can be conducted at Bonneville Dam while visiting the navigation lock. Finally, there are activities included to reinforce what has been learned.

### History Quickie

When Bonneville Dam was built it greatly facilitated navigation. Bonneville Dam flooded the Cascade Rapids that were just upstream. The Bonneville lock, at the time it was built, was the largest single lift lock in the world. The dam flooded the lock at Cascade Locks, Oregon (previously called Whiskey Flats).

#### Important Concepts

The activities in this section will help the students understand the following concepts. Important vocabulary words are in bold print.

#### Navigation Lock

The first Bonneville **navigation lock** was constructed between 1933 and 1938. The original lock is 500 feet long, 76 feet wide and 24.2 feet deep above the sill with an average lift of 60 feet. The construction used 105,000 cubic yards of cement and 2,700,000 lbs. of structural steel.

There is a **lock operator** on duty 24 hours a day, 365 days a year. **Lockages** are provided at no charge for all **watercraft** including; military, commercial, and pleasure craft. Commercial craft do however pay a fuel tax that goes into the Waterways Trust Fund which is used to maintain waterways and helped fund construction of the new navigation lock at Bonneville Dam.

There are strict priorities that guide the operation of federal locks, providing the highest priority for military craft, second highest to commercial craft, and a lowest priority for pleasure and recreational craft. This means pleasure craft may be asked to wait three hours or more during busy periods. Often, pleasure craft will be locked through with non-hazardous barge loads. This is done to conserve the large amounts of water used to operate the lock and expedite lockages.

When a boat is ready to go through the lock, **vessels** with a marine radio can call the **lock operator** and request passage. Those vessels without a radio can speak to the lock operator via the speaker on the entrance wall.

The lock is a simple way of passing boats from one elevation to another. It is like an elevator but it uses water. Water fills and empties from the lock by **gravity flow**.

It takes about 10 minutes to either fill or drain the lock. Allowing for time to enter, tie the craft to a **floating mooring** bit, then later to untie and leave the locks, the entire lockage process takes

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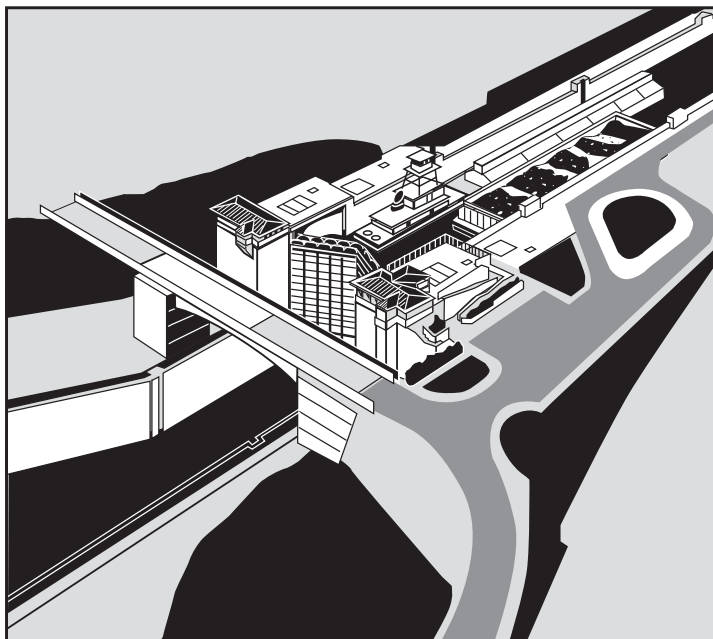
about 30 to 35 minutes. The average lift is 60 feet, with a minimum of 30 feet and a maximum of 72 feet. Each lockage uses about 28 million gallons of water, or enough water that if passed through a generator would supply the electrical energy needs of one Northwest home for a year.

The lock at Bonneville is the busiest lock on the Columbia-Snake river system. More than 10 million tons of cargo pass through Bonneville's lock each year. Frequent cargoes moving upriver include petroleum, oil, gasoline, and fuel oil. **Barges** going **downstream** contain cargoes such as barley, wheat, oats, and other grains, wood products, and building materials. River navigation is possible as far inland as Lewiston, Idaho, some 465 miles from the ocean and an elevation change of about 740 feet.

### New Navigation Lock

The new navigation lock was completed in 1993. The old lock at Bonneville Dam, completed in 1938, was the first and the smallest of eight locks built on the Columbia-Snake Inland Waterway. Construction of the new navigation lock was very important to the region to improve the speed and safety of navigation on the river.

The new lock is 175 feet longer and 10 feet wider than the old lock. It increased the commercial shipping capacity at Bonneville to 30 million tons a year. That should be large enough to handle projected increases in shipping for the next 50 years.



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# Navigation

## Before Your Visit

This section consists of activities designed to prepare your class for their visit to the Navigation Lock at Bonneville Dam.

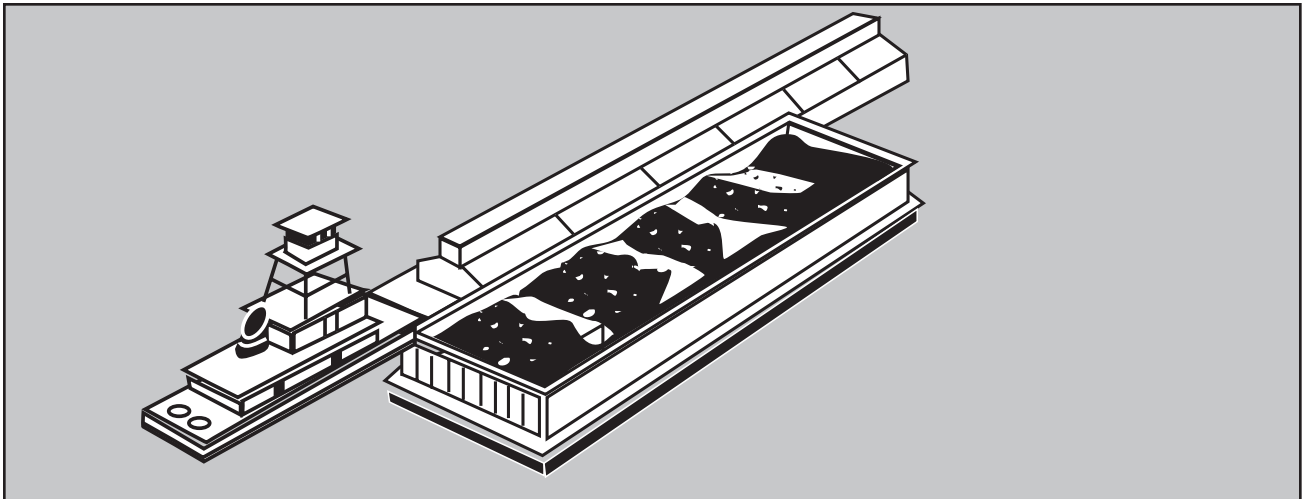
### Activities

#### **The River Navigation Game:**

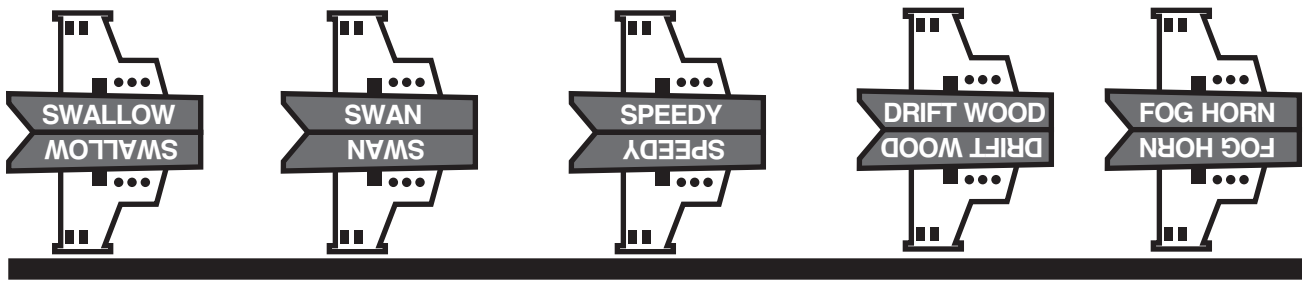
By playing this game your students will get a good idea of how a lock works and how it is used. You will need to make one copy of the game for every four students.

#### **Columbia River Navigation:**

This is a problem solving activity designed for groups. It will be useful in explaining why locks are needed.







## The River Navigation Game

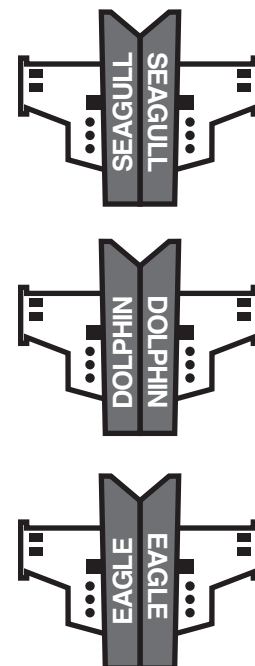
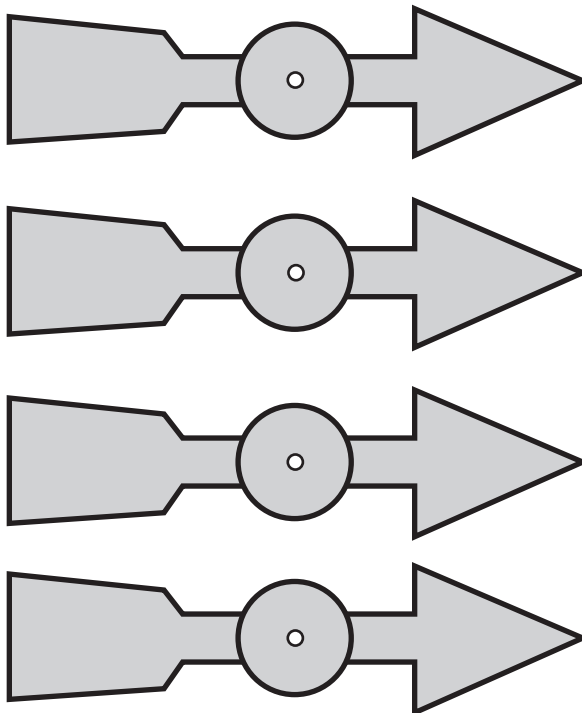
This game will familiarize you with some of the complexities of river navigation, including passage through a lock.

Visits to the lock do not always coincide with the times when the lock is being used. This game will help you understand the process of passage through a lock, even if the lock is not operating.

### To Play This Game:

1. Color the game board and spinner, arrow, and tugboats.
2. Cut them out with scissors.
3. Paste them to cardboard.
4. Attach the arrow to the spinner by piercing the center of both with a pin.

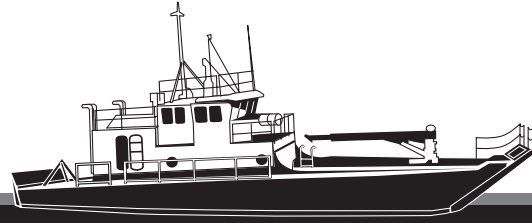
**TO PLAY:** Players spin the spinner to determine who will play first. The player who spins the highest number takes the first turn. Play should then proceed in a clockwise direction. All players should start their boats on the space labeled, “start.” The winner is the first player who navigates back and forth through the locks and arrives at the space labeled, “finish.” Movement “up and down the river” is determined by the number on the spinner and by the hazards and opportunities encountered along the way.







**The Sandwich** - a small dredge



## Columbia River Navigation: Problem Solving

Conduct this activity by dividing the class into groups. Every group should “brainstorm” solutions for every problem and all of the solutions should be written on the blackboard at the end of the brainstorming session.

Brainstorming involves thinking of as many solutions as possible for a problem. No judgments should be passed during this phase. The goal is to collect alternatives. Later, after all of the potential solutions have been collected for a problem, the advantages and disadvantages should be discussed. The solution with the fewest and least important disadvantages and most important advantages is usually the best alternative.

### Here are some navigation problems:

**PROBLEM 1.** In the past huge sand bars formed at the mouth of the Columbia River. Many ships ran aground. How would you solve this?

SOLUTION:

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**PROBLEM 2.** During the 1800's, huge rapids called the Cascades of the Columbia River made it difficult for boats to navigate the Columbia River. How would you solve the problem of improving extremely important river transportation?

SOLUTION:

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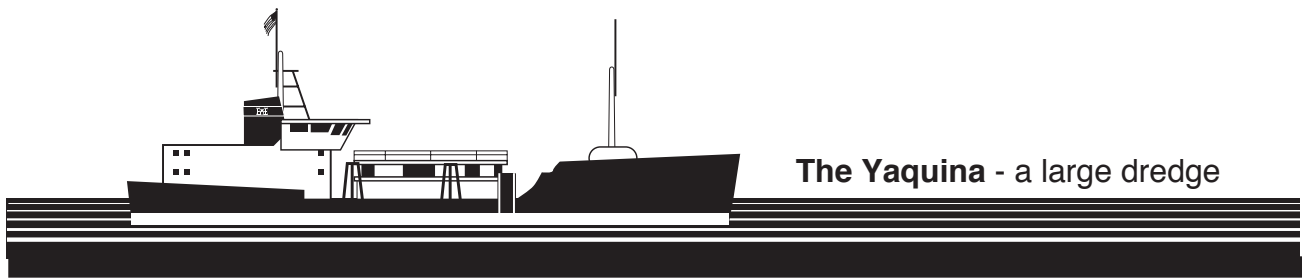
**PROBLEM 3.** You want to find an inexpensive way to move bulky items back and forth between the mouth of the Columbia River and places upriver as far as Lewiston, Idaho. Due to many rapids, the river is not completely navigable.

SOLUTION:

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## Columbia River Navigation: Problem Solving

### Answers:

PROBLEM 1. In the past huge sand bars formed at the mouth of the Columbia River. Many ships ran aground. How would you solve this?

**SOLUTION:** *The Corps of Engineers dredges the channel and builds jetties to block sand accumulation at the mouth of the river.*

PROBLEM 2. During the 1800's, huge rapids called the Cascades of the Columbia River made it difficult for boats to navigate the Columbia River. How would you solve the problem of improving extremely important river transportation?

**SOLUTION:** *The Corps of Engineers helped build a lock near the present location of Cascade Locks. Later, when Bonneville Dam was built, the water rose above the rapids, eliminating them. The Bonneville lock replaced the lock at Cascade Locks.*

PROBLEM 3. You want to find an inexpensive way to move bulky items back and forth between the mouth of the Columbia River and places upriver as far as Lewiston, Idaho. Due to many rapids, the river is not completely navigable.

**SOLUTION:** *The Corps of Engineers built four dams with locks on the lower Columbia and four dams with locks on the lower Snake River. The dams caused the water to cover the rapids, making the river navigable.*



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## Navigation During Your Visit

The following are some suggestions for studying navigation at Bonneville Dam.

The locks are accessible from the Oregon side of the dam. Please contact the Bonneville Ranger Staff to schedule your visit, (541-374-8820). Exhibits at the lock explain its use.

If you are visiting the Washington side, see the lock operator exhibit on the main floor of the Orientation building. Push the button, pick up the phone and listen to information about navigation locks.

### Activities

#### **On Your Way To Bonneville Dam:**

Ask your students to look for and identify boats that may be heading for the lock. You may also be interested in seeing the remains of the lock at Cascade Locks. This lock, located in the Cascade Locks Marine Park, was built by the Corps of Engineers (date). It was partially submerged in the 1930's when the Bonneville Lock and Dam was completed.

#### **Look At A Lock:**

Displays at the navigation lock have information about how boats go through the lock. This activity allows your students to use their imagination to discuss the process of using a lock.

#### **Scavenger Hunt:**

This activity will help students identify the different parts of the lock and what they are used for.





## Look at a Lock

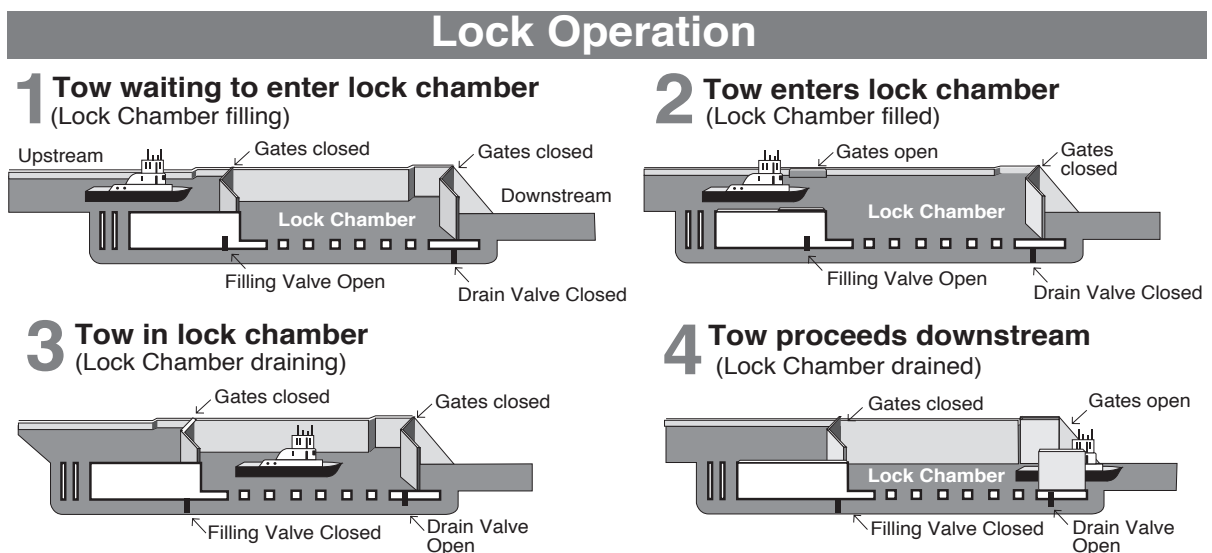
The lock at Bonneville Dam may be thought of as a water-filled elevator which is used by boats to get past the dam. Water enters or leaves the lock through large valves located in the bottom of the lock. No pumps are needed because gravity moves the water in and out of the lock. To fill the lock, the intake valve is opened and water flows into the lock. To drain the lock, a drain valve is opened and water flows out of the lock. The amount of water used for one lockage could, if passed through turbines, generate enough electricity to meet the electrical energy needs of one home for one year!

Walk up to the lock viewpoint. Imagine that a ship is coming. Explain, step by step, how you will help the ship through the lock. Volunteer to explain the first step in the process of locking through. Continue the process with other volunteers until the entire lockage sequence has been explained.

## How It Works

A boat operator coming upriver will radio the lock master and announce when they expect to be at Bonneville Dam. The lock master will open the downstream gates and turn on a green signal light so the boat operator knows the lock is ready to enter. A red signal light tells the boat operator the lock is not ready. The boat will enter the navigation lock and tie up to the floating mooring bits. The lock master will then close the gates and open the upstream water valve to fill the lock. The water has to rise an average of 60 feet, this is the difference in the water level above and below the dam. Pumps are not needed; the force of gravity does all the work. When the lock is full the upstream gate is opened and the boat exits upriver.

Boats going downstream use the same process except that the water is drained from the navigation lock.







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## Scavenger Hunt

This activity will describe some of the more obvious equipment used while operating a navigation lock. Can you find the particular piece of equipment? The first one to find it gets a point. You can double your point if you can explain what the equipment is used for. If you find it and are unable to explain what it is used for, then the first person who can, gets the point.

### Here Are Some Objects To Look For:

**Gates:** The huge metal gates of the lock are hydraulically controlled and weigh about 260 tons each.

**Floating Mooring Bits:** Located in slots on the inside of the lock, these are the devices that the boats must be tied to. The water level changes in the lock (usually 60 feet) so these mooring bits must float. If they did not float, any boat attached firmly to them would either be suspended above the water or held under water as the water level changed.

**Traffic Lights:** Like traffic lights on roads, these lights tell the pilot of a boat when to stop or when to proceed.

**Stoplogs:** These steel reinforced structures are to prevent water from flowing into the lock when the gates are being repaired.

**Office:** This is where the lock operator works, controlling the gates and valves that let water in and out and receiving messages that boats are coming and would like to use the lock.



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## Navigation After Your Visit

These activities are designed to encourage students to review what they learned about the navigation lock.

### Activities

#### **Lock Operator:**

This is an activity involving matching words with their definitions. It deals with the information a lock operator must have.

#### **Word Association Game:**

This game is intended to stretch the students' vocabulary. They must think of words that start with particular letters and are associated with navigation or watercraft.

#### **Did You Know:**

This is a short quiz on navigation.





## Lock Operator

The following is some of the information that a lock operator must know to operate a lock at Bonneville Dam. See how much you know about the lock and about navigation on the Columbia. Write the number of the word in front of the correct definition.

- |                         |       |  |
|-------------------------|-------|--|
| 1. Barge                | _____ | a deep trench in the river bottom dug for safe passage of boats  |
| 2. Channel              | _____ | one definition of this word 'to travel on water'   |
| 3. Corps of Engineers   | _____ | a special boat that digs channels in rivers  |
| 4. Dredge               | _____ | a long pile of rocks that make a wall out into the ocean; used to prevent unwanted sand deposits at the mouth of a river |
| 5. Floating Mooring Bit | _____ | an "elevator" for boats, this elevator uses water to raise or lower boats  |
| 6. Grain And Wood       | _____ | a part of a lock used to tie boats to; it floats   |
| 7. Jetty                | _____ | a large, floating box-shaped boat which is used to move very bulky cargo   |
| 8. Lewiston, Idaho      | _____ | a powerful boat which is used to move barges   |
| 9. Lock                 | _____ | this is how far inland a tug may take a barge  |
| 10. Navigate            | _____ | two cargoes which are sent up the Columbia River   |
| 11. Oil and Fertilizer  | _____ | two cargoes that are transported on the Columbia River   |
| 12. Tug Boat            | _____ | the government agency which built and operates the locks on the Columbia River   |





## Lock Operator

### Answers:

- |                         |                |  |
|-------------------------|----------------|--|
| 1. Barge                | _____ 2 _____  | a deep trench in the river bottom dug for safe passage of boats  |
| 2. Channel              | _____ 10 _____ | one definition of this word 'to travel on water'   |
| 3. Corps of Engineers   | _____ 4 _____  | a special boat that digs channels in rivers  |
| 4. Dredge               | _____ 7 _____  | a long pile of rocks that make a wall out into the ocean; used to prevent unwanted sand deposits at the mouth of a river |
| 5. Floating Mooring Bit | _____ 9 _____  | an "elevator" for boats, this elevator uses water to raise or lower boats  |
| 6. Grain And Wood       | _____ 5 _____  | a part of a lock used to tie boats to; it floats   |
| 7. Jetty                | _____ 1 _____  | a large, floating box-shaped boat which is used to move very bulky cargo   |
| 8. Lewiston, Idaho      | _____ 12 _____ | a powerful boat which is used to move barges   |
| 9. Lock                 | _____ 8 _____  | this is how far inland a tug may take a barge  |
| 10. Navigate            | _____ 11 _____ | two cargoes which are sent up the Columbia River   |
| 11. Oil and Fertilizer  | _____ 6 _____  | two cargoes that are sent down the Columbia River  |
| 12. Tug Boat            | _____ 3 _____  | the government agency which built and operates the locks on the Columbia River   |





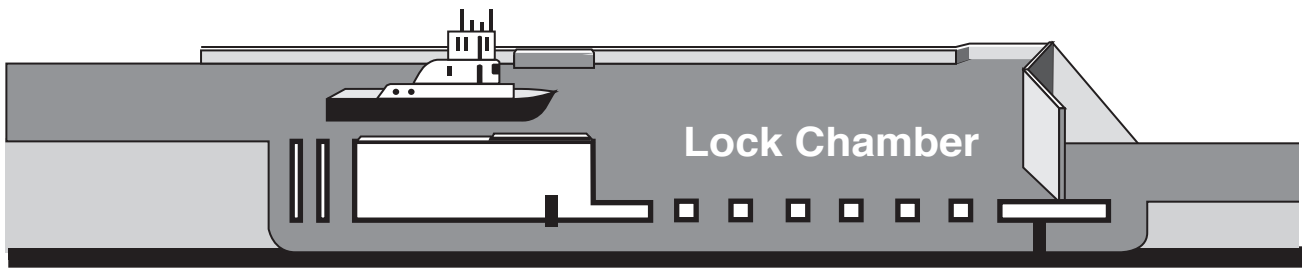


## Word Association Game

To play this game you must think of a word that relates to both the Columbia River and to navigation lock or watercraft. The word must start with a letter in the word “Columbia” which is written vertically on the page. For instance; the letter “C” in Columbia will have two words that start with the letter “C” and associate with either navigation lock or watercraft, horizontally next to it. There are no incorrect answers as long as the answer can be explained.

	Navigation Lock	Watercraft
C	_____	_____
O	_____	_____
L	_____	_____
U	_____	_____
M	_____	_____
B	_____	_____
I	_____	_____
A	_____	_____



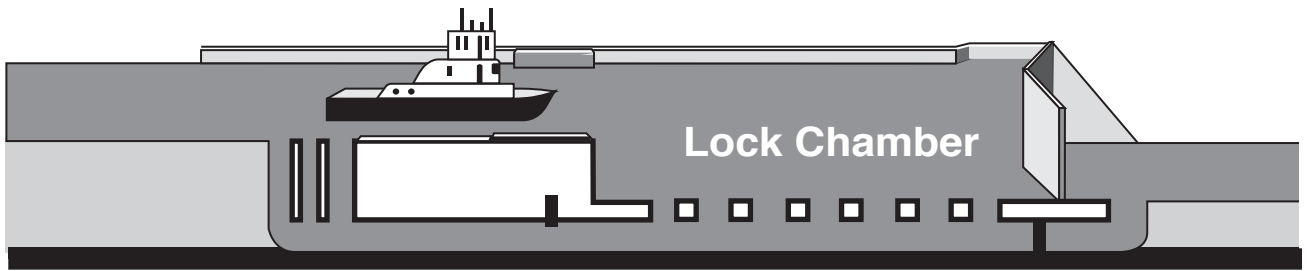


## Word Association Game

### Example For Teachers:

	Navigation Lock	Watercraft
<b>C</b>	cargo	commercial
<b>O</b>	operator	ocean liner
<b>L</b>	lumber	loaded
<b>U</b>	up river	untie
<b>M</b>	mooring bits	move
<b>B</b>	boats	barges
<b>I</b>	inside	inland trade
<b>A</b>	Army Corps of Engineers	agricultural products





## Did You Know?

Did you know that if the water which is used for filling the lock were passed through a turbine, it would make enough electricity to meet the electrical needs of a home for one year! The new navigation lock can conserve water by passing the same amount of barges by the dam in one lockage that the old lock passed in five lockages.

The water to fill the lock comes from \_\_\_\_\_

The water drained from the lock goes \_\_\_\_\_

Why are locks necessary for river transportation \_\_\_\_\_

\_\_\_\_\_

Why is river transportation important \_\_\_\_\_

\_\_\_\_\_

How is a lock like an elevator? How is it different \_\_\_\_\_

\_\_\_\_\_

How is a lock like your bathtub? How is it different \_\_\_\_\_

\_\_\_\_\_

How else is the water from the Columbia River used \_\_\_\_\_

\_\_\_\_\_

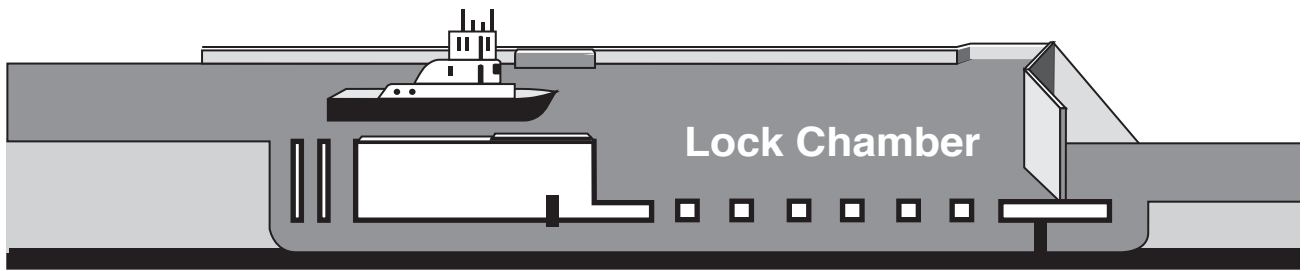
What does “conserve” mean \_\_\_\_\_

\_\_\_\_\_

Why is it important to conserve the water in the Columbia River \_\_\_\_\_

\_\_\_\_\_





## Did You Know?

### Answers

The water to fill the lock comes from Upriver.

The water drained from the lock goes Downriver.

Why are locks necessary for river transportation Locks are built so boats can get around dangerous rapids or past a dam.

Why is river transportation important Goods are transported quickly, safely and economically on a river.

How is a lock like an elevator? How is it different A lock lifts boats from one elevation to another like an elevator. It uses water, an elevator doesn't.

How is a lock like your bathtub? How is it different The lock is filled and emptied with the force of gravity upon water like a bathtub but the lock is much larger than a bathtub

How else is the water from the Columbia River used Columbia River water is used to make electricity, irrigate and for recreation. Fish and wildlife also use Columbia River water.

What does "conserve" mean To conserve means to use something without destroying it.

Why is it important to conserve the water in the Columbia River The Columbia River water is used for many important things

